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IS 5921-5 (1987): Metal Clad Base Materials for Printed Circuits for Use in Electronic and Telecommunication Equipment, Part 5: Epoxide Cellulose Paper Copper Clad Laminated Sheet of Defined Flammability (vertical burning test) [LITD 5: Semiconductor and Other Electronic Components and Devices]



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Indian Standard

SPECIFICATION FOR
METAL CLAD BASE MATERIALS FOR
PRINTED CIRCUITS FOR USE IN ELECTRONIC
AND TELECOMMUNICATION EQUIPMENT

PART 5 EPOXIDE CELLULOSE PAPER COPPER CLAD
LAMINATED SHEET OF DEFINED FLAMMABILITY
(VERTICAL BURNING TEST)

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Indian Standard

**SPECIFICATION FOR
METAL CLAD BASE MATERIALS FOR
PRINTED CIRCUITS FOR USE IN ELECTRONIC
AND TELECOMMUNICATION EQUIPMENT**

**PART 5 EPOXIDE CELLULOSE PAPER COPPER CLAD
LAMINATED SHEET OF DEFINED FLAMMABILITY
(VERTICAL BURNING TEST)**

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SPECIFICATION FOR METAL CLAD BASE MATERIALS FOR PRINTED CIRCUITS FOR USE IN ELECTRONIC AND TELECOMMUNICATION EQUIPMENT

PART 5 EPOXIDE CELLULOSE PAPER COPPER CLAD LAMINATED SHEET OF DEFINED FLAMMABILITY (VERTICAL BURNING TEST)

0. FOREWORD

0.1 This Indian Standard (Part 5) was adopted by the Indian Standards Institution on 19 March 1987, after the draft finalized by the Printed Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard (Part 5) is to be used in conjunction with IS : 5921 (Part 1)-1983* which is a necessary adjunct to this standard.

0.3 While preparing this standard, assistance has been derived from the following:

IEC Document 52 (Central office) 238 Draft — Revision of Publication 249-2: Base materials for printed circuits: Part 2: Specifications; Specification No. 3: Epoxide cellulose paper copper clad laminated sheet of defined flammability (vertical burning test), International Electrotechnical Commission (IEC).

NEMA: Industrial laminated thermosetting products LI-1-1977, National Electrical Manufacturers' Association, USA.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

†Rules for rounding off numerical values (revised).

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rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part 5) specifies the requirements for epoxide cellulose paper copper clad laminated sheet of defined flammability (vertical burning test) for use in printed wiring in telecommunication and allied electronic equipment.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions as given in IS : 1885 (Part 6)-1978* shall apply.

3. MATERIAL AND CONSTRUCTION

3.0 The sheet consists of an insulating base with metal foil bounded to one or both sides.

3.1 Insulating Base — The base material shall be epoxide resin bonded cellulose paper laminate. Its flame resistance is defined in terms of flammability requirement specified in 8.3.

3.2 Metal Foil — The base material shall be covered with copper foil as specified in IS : 10922-1984†.

4. MARKING

4.1 The marking shall be in red colour in accordance with 3 of IS : 5921 (Part 1)-1983‡. If letters or numbers are used, these shall be upright in the machine direction as shown below:

A	A	A	A	↑	12	12	12
A	A	A	A		12	12	12
A	A	A	A		12	12	12
A	A	A	A	↓	12	12	12
				machine			
				direction			

*Electrotechnical vocabulary: Part 6 Printed circuits (*first revision*).

†Specification for copper foil for use in the manufacture of copper-clad base materials.

‡Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

5. TESTS

5.1 The provisions of 4 of IS : 5921 (Part 1)-1983* shall apply except as modified by 5.1.1. The methods of tests shall be as described in IS : 5921 (Part 1)-1983*.

5.1.1 Acceptance Tests — In addition to the tests specified in 4.1.2 of IS : 5921 (Part 1)-1983*, flammability test shall also be carried out as acceptance test. Sampling plans and acceptance levels may be agreed to between the purchaser and the supplier.

5.1.2 Routine Tests — The following tests may be carried out as routine tests:

- a) Visual examination, and
- b) Dimension and tolerances.

6. ELECTRICAL PROPERTIES

6.1 The electrical properties shall meet the requirements as given in Table 1.

7. NON-ELECTRICAL PROPERTIES OF THE COPPER-CLAD SHEET

7.1 Surface Finish of the Copper-Clad Face

7.1.1 The copper-clad face shall be substantially free from blisters, wrinkles, pinholes, deep scratches, pits and resin. Any discolouration or contamination shall be readily removed with a hydrochloric acid solution of density 1.02 g/cm³ or with a suitable organic solvent. The surface shall be inspected in accordance with 6.2 of IS : 5921 (Part 1)-1983*. The surface finish of the copper-clad face shall be such as not to conceal imperfections.

7.1.2 The surface of the copper foil shall be free from scratches of depth greater than 0.010 mm or 1/5 of the nominal thickness of the copper foil, whichever is the lower.

7.1.3 The total length of scratches of depth greater than 0.005 mm but not greater than 0.010 mm shall not exceed 1 m per square metre of the total area of the sheet under test.

7.1.4 The area of any one or number of pinholes in an area of 0.5 m² shall not exceed the area of a circle of diameter 0.125 mm.

7.1.5 No sheet shall have more imperfections of the types listed than those permitted by Table 2.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

TABLE 1 ELECTRICAL PROPERTIES

SL No.	PROPERTY	(Clause 6.1)	
		TEST METHOD [CLAUSE OF IS : 5921 (Part 1)-1983*]	REQUIREMENTS
i)	Resistance of foil	5.1	As specified in IS : 10922-1984†
ii)	Surface resistance while in humidity chamber (optional)	5.2	2 000 M Ω , <i>Min</i>
iii)	Surface resistance after recovery	5.2	20 000 M Ω , <i>Min</i>
iv)	Volume resistivity while in humidity chamber (optional)	5.2	800 M Ω m, <i>Min</i>
v)	Volume resistivity after recovery	5.2	2 000 M Ω m, <i>Min</i>
vi)	Surface corrosion	5.7	No visible corro- sion products in the gap
vii)	Corrosion at the edge	5.8	Positive pole: not worse than A/B Negative pole: not worse than 1:6
viii)	Relative permittivity after damp heat and recovery	5.4	The average value shall not exceed 5.0
ix)	Dielectric dissipation factor after damp heat and recovery	5.4	The average value shall not exceed 0.05
x)	Surface resistance at 100°C	5.2.4	1 000 M Ω , <i>Min</i>
xi)	Volume resistivity at 100°C	5.2.4	100 M Ω m, <i>Min</i>

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

†Specification for copper foil for use in the manufacture of copper-clad base materials.

TABLE 2 TYPES, SIZES AND PERMITTED NUMBERS OF IMPERFECTIONS
(Clause 7.1.5)

Sl. No.	TYPE	SIZE (LENGTH, UNLESS OTHERWISE INDICATED)		NUMBER OF IMPERFECTIONS PERMITTED	
		Above	Not above	In Any Sheet of Area About 1 m ²	In Any Area of 300 mm × 300 mm
(1)	(2)	(3)	(4)	(5)	(6)
	i) Inclusions	—	0.1	Any number	Any number
		0.1	0.25	30	4
		0.25	—	0	0
	ii) Indentations	—	0.25	Any number	Any number
		0.25	1.25	13†	3*
		1.25	3.0 or width 1.0	3†	1*
		3.0 or width 1.0	—	0	0
	iii) Bumps	—	0.1	Any number	Any number
		0.1	4.0 or height 0.1	10	2
		4.0 or height 0.1	—	0	0
	iv) Wrinkles/ blisters	Of any size		0	0

NOTE 1 — For sheets of 1 m² or greater, the values of the fifth column apply for any area of 1 m²; for the same sheets in any area of 300 × 300 mm, however, the values of the sixth column apply. For sheets smaller than 1 m², the sixth column applies for any area of 300 × 300 mm.

NOTE 2 — For cut panels, smaller sizes and other numbers of imperfections may be agreed upon between the purchaser and the supplier.

*The total for these sizes of indentations is 3.

†The total for these sizes of indentations is 13.

7.2 Thickness

7.2.1 The thickness of a sheet, including the metal foil, shall not depart at any point from the nominal thickness by more than the appropriate value given below:

<i>Nominal Thickness</i>	<i>Deviation</i>
mm	mm
0.5	± 0.07
0.7	± 0.09
0.8	± 0.09
1.0	± 0.11
1.2	± 0.12
1.5	± 0.14
1.6	± 0.14
2.0	± 0.15
2.4	± 0.18
3.2	± 0.20
6.4	± 0.30

7.2.2 The thickness and tolerances do not apply to the outer 25 mm of the trimmed laminated sheet as supplied by the vendor. At least 90 percent of the area, regardless of size, shall be within the tolerances given, and at no point shall the thickness vary from the nominal by a value greater than 125 percent of the specified tolerance.

7.2.3 For any nominal thickness within the range of nominal thickness 0.5 to 6.4 mm, which is not given in the table of nominal thickness and corresponding deviations, the deviation applicable to the thickness shall be that for the next greater nominal thickness given in the table.

7.3 Bow and Twist — The bow and twist requirements are specified in Table 3.

7.4 Properties Related to the Copper Foil Bond — These properties are specified in Table 5.

7.5 Punching and Machining — Methods of test for punching properties and requirements for these are matters of agreement between the purchaser and the supplier.

7.6 Solderability

7.6.1 When the sheet is tested as specified in 6.8 of IS : 5921 (Part 1)-1983* and in accordance with the times and temperatures specified below, the soldered areas shall be covered with a smooth and bright solder coating. Scattered imperfections, such as, pin-holes, shall not occur on more than 5 percent of the surface and shall not be concentrated in one area. At least six specimens out of each batch of ten shall pass the test.

a) Wetting

<i>Nominal Thickness</i>	<i>Thickness of Copper</i>	<i>Maximum Wetting Time</i>	<i>Temperature</i>
(mm)	(μm)	(s)	($^{\circ}\text{C}$)
0.5 up to 1.6	35 (305 g/m ²)	2	235 $^{+5}_{-0}$
Over 1.6 up to 6.4	35 (305 g/m ²)	3	235 $^{+5}_{-0}$
0.5 up to 6.4	70 (≤ 10 g/m ²)	3	235 $^{+5}_{-0}$

b) Dewetting

Test specimens shall remain in contact with the molten solder for

5 $^{+1}_{-0}$ s at 235 $^{+5}_{-0}$ $^{\circ}\text{C}$.

NOTE — For thickness of copper greater than 70 μm (610 g/m²), the wetting and dewetting times shall be agreed between purchaser and supplier.

8. NON-ELECTRICAL PROPERTIES OF THE BASE MATERIAL AFTER COMPLETE REMOVAL OF THE COPPER FOIL

8.1 Appearance of the Base Material — The base material shall be substantially free from pits, holes, scratches, porosity and resin inclusions and substantially uniform in colour. A small amount of irregular variation of colour is permissible.

8.2 Flexural Strength — This test is applicable to sheets not thinner than 1.0 mm of nominal thickness. The test should be carried out in accordance with 7.1 of IS : 5921 (Part 1)-1983*. The flexural strength shall not be less than 11 000 N/cm².

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

TABLE 3 BOW AND TWIST

(Clause 7.3)

SL No.	PROPERTY	TEST METHOD [CLAUSE OF IS : 5921 (Part 1)-1983*]	REQUIREMENTS
(1)	(2)	(3)	(4)
i)	Bow	6.6	Shall not exceed the value given by the formula $d (L/1\,000)^2$ mm, where L is the length of the straight edge in millimetres and d is as given in Table 4
ii)	Twist	6.7	Shall not exceed the value given by the formula $d (L/1\,000)^2$ mm, where L is the distance in millimetres between the corner of the sheet not in contact with the horizontal surface and the diagonally opposite corner, and d is as given in Table 4.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment : Part 1 General requirements and tests (*first revision*).

TABLE 4 PARAMETERS RELATED TO BOW AND TWISTS

(Table 3, Col 4)

SL No.	NOMINAL THICKNESS mm	COPPER FOIL ON ONE SIDE, d		Twist Not Over 70 μm^*	COPPER FOIL ON BOTH SIDES, d Bow and Twist Not Over 70 μm
		Bow			
		Not over 35 μm^*	Over 35 μm^* up to 70 μm^*		
(1)	(2)	(3)	(4)	(5)	(6)
i)	0.5 to 1.2	55	105	25	25
ii)	Over 1.2 to 1.6	38	75	20	20
iii)	Over 1.6 to 3.2	32	55	15	15
iv)	Over 3.2 to 6.4	27	40	12	12

NOTE 1 — Limits for laminates clad with foil of nominal thickness greater than 70 μm (610 g/m²) shall be subject to agreement between purchaser and supplier.

NOTE 2 — The requirements for bow and twist apply only to sheet sizes as manufactured and to cut pieces having neither length nor width less than 460 mm.

*35 μm (305 g/m²); 70 μm (610 g/m²)

TABLE 5 PROPERTIES OF COPPER FOIL BOND

(Clause 7.4)

SL No.	PROPERTY	TEST METHOD [CLAUSE OF IS : 5921 (Part 1)-1983*]	REQUIREMENTS
(1)	(2)	(3)	(4)
i)	Pull-off strength	6.11	Not less than 50 N
ii)	Peel strength after heat shock of 10 s by methods a or b or 5 s by method c	6.10.4 (a, b or c)	} Not less than 1.2 N/mm
iii)	Peel strength after dry heat at 100°C	6.10.5	
iv)	Peel strength after exposure to solvent vapour 1.1.1 trichlorethylene	6.10.6	No blistering, no delamination
NOTE — For solvents other than trichlorethylene, requirements shall be agreed upon between purchaser and supplier.			
v)	Peel strength after simulated plating	6.10.7	Not less than 0.8 N/mm
vi)	Peel strength at high temperature (100°C)	6.10.8	Not less than 0.6 N/mm
NOTE — In case of difficulties due to breaking foil or reading range of the device for measuring the force the measurement of the peel strength at high temperature may be carried out using conductor widths larger than 3 mm.			
vii)	Blistering after 10 s heat shock	6.9	No delamination, no blistering

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8.3 Flammability — The vertical burning test shall be carried out in accordance with 7.2.3 of IS : 5921 (Part 1)-1983*. The following requirements shall be met:

- a) No specimen shall burn with flaming combustion for more than 30 s after either applications of test flame;
- b) The total flaming combustion time shall not exceed 250 s for each set of 5 specimens;
- c) No specimen shall burn with flaming or glowing combustion up to the holding clamp;
- d) No specimen shall burn with glowing combustion which persists beyond 60 s after the second removal of the test flame; and
- e) The material shall not drip flaming particles which ignite the tissue paper.

8.4 Water Absorption — It shall be measured in accordance with 7.3 of IS : 5921 (Part 1)-1983* and shall meet the requirement given below. In case of thicknesses not included below, the requirement for next greater thickness shall apply:

<i>Nominal Thickness</i>	<i>mg (Max)</i>
mm	
0.5	30
0.7	30
0.8	30
1.0	33
1.2	35
1.5	40
1.6	40
2.0	45
2.4	50
3.2	65
6.4	80

9. PACKAGING

9.1 The sheets shall be adequately packed and protected in cases or crates to avoid damage in transit and during storage.

*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (first revision).

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